MOUNT ZION CHURCH STABILIZATION
Final Recommendations Report
22 May 1998

QUINN EVANS / ARCHITECTS
1214 Twenty-Eighth St, NW
Washington, DC 20007

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FINAL RECOMMENDATIONS REPORT

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1.0 INTRODUCTION - REPORT SCOPE

This document is the follow-on to the Historic Structure Report (HSR) for this building. The HSR documents the original and existing conditions of the structure and provides a history of the construction and related events which have contributed to the significance of the site and locale. This report distills that information and provides recommendations for repairs, maintenance and restoration treatments. Further, this report focuses on the high priority work efforts with the objective that these work efforts will be implemented within the immediate future. Because of limited funding, these efforts are limited to structural stabilization. Comprehensive rehabilitation and full utilization of the structure is a future objective which cannot be accomplished within the current funding limitations.

The conceptual phase for a stabilization project is critical to the development of the implementation of the selected recommendations. The field survey effort provided a wealth of information from many sources. Further collection of field data and the technical analysis of the foundations and soils has resolved issues critical to the selection of a preferred course of action for stabilization measures.

The intent of the 'stabilization' effort is to arrest the physical deterioration of the structure as much as possible within the budgetary restraints. Once implemented, the chances of localized structural failure, or a catastrophic building failure, are greatly reduced. On the other hand, if these measures are not implemented, the chances of limited or general structural failure increase every year. Stabilization differs from a 'rehabilitation' or 'restoration' in that the work addresses specific emergency conditions threatening the structure rather than a comprehensive project to correct the full range of deterioration and preservation treatments aimed at full utilization of the structure.

This report for the stabilization of the Mt. Zion Church serves several purposes:

- Presents final stabilization recommendations
- Describes these recommendations, levels of urgency, and estimated implementation costs
- Identifies an implementation approach and schedule
- Outlines future rehabilitation treatments toward full utilization

Appended to the report are the findings of the consultants, testing results and progress set of the measured floor plan drawings.

This report provides final recommendations for stabilization. Upon approval of the findings, the consultants will begin preparation of drawings and specifications. Once approved, the drawings and specifications would be let for bid to specialty restoration contractors. The findings are reviewed by representatives of Loudoun County and the Mount Zion Church Preservation Association (MZCPA).

2.0 SUMMARY OF EXISTING CONDITIONS

A more comprehensive description of original and existing conditions is found in the Historic Structures Report which accompanies this report.

2.1 Exterior Building Conditions - General

Exterior Masonry Walls: As the focus of the most notable signs of distress, the deflection and subsidence of the exterior masonry walls is of the utmost concern. As was documented in Ric Ortega's stabilization report of December, 1996, the subsidence and lateral shifting of the west wall remains the single most dire condition threatening the structure. Localized stress cracks and deflection around "S" plates tying the east and west walls together via large iron chains remains. Heavy timber shoring has been erected on the exterior to arrest further outward deflection of the center third of the west elevation. While this is clearly serving to stabilize a substantial lateral deflection, the complexity of the settlement and subsidence presents a challenging structural problem.

Wet mortar in the lower courses of the northwest corner of the structure was extremely soft. The condition may have been worsened by the use of portland cement based mortar for selective re-pointing. This modern mortar is much harder and more rigid that the original lime based materials. Unfortunately, this has caused accelerated deterioration of the surrounding brick and mortar. A mortar analysis has been completed which indicates that the mortar does not conform to conventional proportions for sand and lime. Further, there is a lot of organic material which is not usually found in sound mortars. The result is a mortar of marginal strength and durability with is also quite absorptive. This mortar barely satisfies the structural and weathering requirements that are placed on it. A mortar analysis laboratory report is in the appendix.

Wall openings at windows and doors are spanned with brick jack arches. Most of these arches have subsided with vertical cracking evident within the arch and often extending from the spring point of the arch diagonally outward. Several jack arches were noted to be bulging outward. Portland cement patching of the arches may have caused accelerated spalling of the surrounding brick and mortar.

The stone foundation is constructed of locally obtained basalt cobbles and soft, sandy mortar. The scale of stone utilized in the foundations varies widely, but is predominantly smaller in size (about 10"x 14"). This creates a foundation lacking the ability to resist shear stresses required to span areas of poor soil with variable load bearing capacity.

Brick chimneys constructed within the north and south walls are sound, except for the portions projecting above the roof. The increased weathering of these roof-top projections has caused deterioration resulting in the use of portland based mortar repairs and black waterproofing mastic over the years. Localized plaster crumbling and staining of interior walls is attributed

to thermal stress from wood-burning stove exhaust and excessive moisture from leaking chimney caps.

Windows: Original 8 over 8 double hung wood windows have been well protected by the shutters. The lack of excessive paint build-up on the woodwork was notable. The result is that the original crisp detail of the woodwork is still clearly discernable. This is quite rare for a structure of this age. While some broken panes were noted, most of the original glass is in place. The windows lack counterweights in favor of simple wood sash props attached to a side rail that support the lower sash in any one of several notches in the window trim. The upper sash is fixed. The balcony windows were inaccessible as protective interior gypsum board coverings have been constructed inside the window openings. Some loss of window glazing (putty) and peeling paint on the exterior will require repair. Most exterior sills are weathered with raised grain due to long term exposure and subsequent deterioration of the sapwood.

Shutters: Shutters for the first floor have raised panels with mortise and tenon construction. The upper floor has fixed louver wooden shutters. As would be expected, the shutters have weathered substantially over the years. A number of repairs were noted. Many of the original self locking hinge sets have been replaced with modern cylinder hinges. Plywood was used to patch a shutter panel on the south elevation. Missing louvers were noted, but the most common deficiency was severely damaged paint with weathered wood substrate.

Doors: Four exterior doorways provide access to the interior. The two entry doors on the east each have a pair of three paneled solid wood doors. The north elevation doorway provides access to the northeast stair to the balcony and consists of a single leaf six panel door. This door was braced and nailed closed upon survey. It appears to be otherwise operable. The southeast doorway provides access to the southeast stairway and consists of a single leaf vertical beaded board door. As this door differs from the others, it is assumed that this is the newer door provided to replace the door destroyed during the Civil War era. All doors have four lite transoms with wooden sills which form the head frame for the doors. All doors have modern hardware locking sets with the exception of the hinges which appear to be original.

Roof: The roof is standing seam galvanized metal over sheathing of varying widths. Selected areas of metal roofing have been coated heavily with black waterproofing mastic in the last ten years, presumably in response to leakage. It is apparent from the attic space that the roof continues to leak, causing deterioration to both the structure and finish materials. Nails anchoring the roofing to the lath are located in the middle of the panning rather than concealed below the standing seam joining the pans. This has presented literally hundreds of potential leakage sources. Waterproofing was also applied liberally to the brick chimneys and splattered on exterior masonry walls.

2.2 Interior Building Conditions - General

Floors: Interior floors throughout the structure are constructed of varnished wood boards of varying widths and lengths with carpet runners installed in the sanctuary aisles and on the pulpit steps and platform. We were unable to fully inspect floor framing as there is no

access to the crawl space. However, a limited view is possible through the terra-cotta ventilation pipes which penetrate the foundation walls. From these vantage points, it is clear that the wooden joists have been repaired with the addition of a sistered joist to increase bearing within the stone foundation wall. Apparently the ends of the joists which are implanted in the stone foundation had rotted away from either moisture or insect damage. Also, there appeared to be evidence of water staining and termite tunnels visible in other areas of the crawl space. The flooring appears to be in good condition. The carpet and padding are heavily deteriorated.

Walls: Interior walls are plaster on wood lath and show a moderate level of deterioration in the form of cracking due to settlement of the masonry as well as staining and delamination of plaster due to moisture infiltration.

Wood Trim, Columns, and Pews: Decorative wood trim elements, columns and pews were found to be in good condition. All are decorated with a very elaborate and intact paint coating treatment known as 'wood graining.' This was a popular treatment during the nineteenth century.

Attic: Widespread evidence of moisture and termite and/or beetle damage was immediately evident throughout the attic. Large amounts of bat and bird droppings had allowed moisture to rot the sanctuary ceiling boards from above. The bird droppings have recently been totally removed and the area sanitized. Further, protective screening was placed in gaps to block entry of the avian pests. Structural issues are described in detail below in section 2.4 - Structural Conditions.

2.3 Site Drainage

The clay characteristics of the soil suggest that surface water will slowly percolate into the sub-soil. During heavy rains, the water is more likely to puddle and flow to low spots. The topography survey shows that the grade of the site directs drainage toward the west and generally away from the building except at the northwest corner. An area of negative drainage (flowing toward the building instead of away) exists along the west end of the north wall. Ponding was noted in this area during our field survey. This excess moisture affects the foundation walls by saturating the mortar and stones. This condition of negative drainage should be corrected.

2.4 Structural Conditions

See attached report form Richard Ortega for more detailed description of the structural issues. The following is a summary of his findings:

Stone Footings: A number of factors have been identified that contribute to an increasingly troubling view of the stone foundations. The loss of cohesion in the mortar between the stones means that there may be little resistance to stresses within the foundation. Secondly, the relatively small size of the stones, and the roundness, may result in a foundation that is inherently weak. Of particular concern is that the ability of the foundation to provide adequate transfer of loads from the structure to the soil in isolated areas where the soil may not provide adequate bearing. Lastly, it was noted that the foundations are comparatively

shallow. At the west end, they are only about 20 inches deep. Modern construction standards would normally require a depth of at least 36 inches to avoid problems of frost heave during extremely cold weather. With shallow foundations, there could arise the case where the upward thrust from the frozen ground literally lifts the building. This is a rare occurrence, but the nature of the fractures visible in the brick walls and stone foundations could be the result of this event.

Foundation and Soil Conditions: A geo-technical consultant was hired to perform soils testing in order to determine its physical properties. Two sets of investigation were completed. In the first, test pits were excavated against the foundation, to the bottom of the footings, in three locations: approximate center of the north, south, and west elevations. The soil's capacity to support the loads expected for a structure of this size was confirmed. However a high "fat clay" content was also noted. This clay laden soil is relatively plastic and tends to expand and contract depending on the amount of water present within the soil. This would cause a heaving or lifting of the foundation where there was wet "fat clay" and a subsidence or lowering of the foundation where the clay was dry. Based on these findings, it was determined that a second round of analysis was justified to confirm the hypothesis, especially in view of the other conditions noted for the stone foundations. From this second round of investigation, it was determined that there were differing layers of clay soils, with intermediate layers of loam. These layers could literally fill with water since the clay layer below would not permit the percolation of water. This accumulation of water is known as "perched" water, since it is perched, or trapped, between two clay layers. During severely cold weather, one can easily see how this water could freeze and cause significant upward thrust. If this occurs under the stone foundations, the frost heave would be substantial.

The soils analysis leads the investigators to the conclusion that the damage visible to the brick walls and stone foundations is most likely the result of the rare occurrence of frost heave. This is exacerbated by the negative site drainage and the shallow foundations. Actions which would eliminate the negative drainage and reduce the likelihood of frost heave should be the first priority. When implemented, these would greatly reduce the structural threats to the walls and foundations.

From these conclusions, it would not seem justified to underpin the stone foundations with concrete footings. First, the soil bearing pressure is apparently adequate for this structure. There is no apparent need to increase this capacity through underpinning. Secondly, the nature of the stonework of the foundations raises serious questions about the viability of an underpinning operation. We had serious doubts that underpinning could be successfully undertaken. It would either be very, very expensive, or worse, might cause collapse or a great deal of other related stone replacement work. The intent here is to undertake the repairs and site work noted, and continue to monitor the condition of the structure. This monitoring could be undertaken over a several years. If movement continues, then the issue of underpinning may have to be re-visited.

Brick Walls: Significant distortions continue to be evident in the west wall, however the movement of the wall seems to have been arrested by the heavy timber shoring installed in 1997. The structural report (attached as an appendix) surmises that this support would likely limit the scope of a failure to a localized event rather than a general or catastrophic

failure. As long as this prop remains functional, the west wall would not be expected to collapse.

Brick Jack Arches: Cracking through the arches was noted throughout the structure. The structural report states that the design of the arches as originally conceived was flawed as it was too shallow for the span of the openings. Brick can, and have, fallen out because of this failure.

Floor Framing: The crawl space has not been accessible to view up to this time, with the exception of limited observation through the vent ports and use of the "borescope." However, from these observations, there is water staining, fungus and perhaps termite tunnels visible. If access hatches could be established at three points in the floor, full inspection would be possible. Based on the limited observations made to this time, it is recommended that large groups of people not be permitted within the structure. It is assumed that some of the joists are in a weakened state and overloading could cause localized failure. This could result in a portion of the flooring collapsing into the crawl space. To reduce the chances of this happening, the investigators recommend that the quantity of visitors to the interior be limited. The limitation is somewhat arbitrary and is based on previous experience with small groups of people which have not caused any deflection in the flooring. The guidelines of no more than 15 people inside the structure, and that these fifteen would be relatively evenly dispersed through the inside, is the maximum allowable visitation.

Assuming the urgent stabilization repairs suggested in this report are completed, and as long as the quantity of visitors is kept to this low level, the interior can continue to be open to the public.

Roof Framing: The roof framing was carefully inspected by Ric Ortega (see report in appendix). The heavy timber framed roof trusses display signs of termite or beetle infestation and rot. Several of the primary truss joints, the heal joints, have been compromised by rot and/or infestation. A loss of bearing along the west wall due to its displacement threatens to leave purlins unsupported.

The deterioration of the roof trusses leave them prone to sudden catastrophic failure if loaded by unusual loads such as a heavy snow, ice or high wind conditions.

2.5 Summary

In summary, the building is in a fragile state at this time. If it were subjected to severe freezing conditions, heavy roof loads from snow, or a large gathering of people on the inside, failure of a part of the structure is a distinct possibility. This localized failure could lead to a more generalized collapse. The repairs identified in the next chapter will stabilize the structure to reduce this risk greatly so that limited use by the public would be possible and there would be little worry about severe weather, snow or ice conditions.

3.0 RECOMMENDATIONS

3.1 Stabilization Approach

The work listed below is not intended to be a comprehensive project for the building, but rather is very narrowly focused. This work meets two specific criteria which are:

- Repair and reinforce the structure to reduce the risk of structural failure and to permit limited use of the interior

- Prioritize the work elements so that they can be accomplished within a construction budget with a maximum limitation of $100,000. Further, these high priority work elements will be packages into a single set of construction documents and let for competitive bids.

There is also the interest on the part of the MZCPA to seek donation of funds and services. We have determined that lower priority work elements, oriented to the general preservation of the building and site, would be candidates for such donations. These will be identified below, but not become part of the construction document package.

3.2 Structural Repairs and Reinforcements

The following work assumes that the existing heavy timber bracing on the west side of the building remains in place and that it will be inspected annually to assure that the wood remains in good condition and that it remains in solid contact with the wall.

- Reinforce the wooden roof trusses using a combination of steel flitch plates, bolted to the heal joints, and other methods of reinforcing the damaged heal joints.
- Repair and reinforce other localized areas of the wooden trusses members using epoxy injections or reinforcement plates.
- Provide temporary shoring to permit construction access into the attic.
- For the exterior brickwork, repoint or rebuild the jack arches of each window and door opening
- For the stone foundations, repoint eroded joints and replace missing or fractured individual stones.

We estimate that the cost of these elements would be approximately $25,500

3.3 Site Drainage Recommendations

We believe the problems of negative drainage, and the possible occurrence of frost heave during severe cold weather can be greatly reduced with simple re-grading of the earth adjacent to the structure. Thus, we recommend:

- Build-up the earth against the stone foundation walls on the west, north and south sides about 12 inches, tappering outwards. The new grade will establish positive

drainage of surface water and will provide thermal insulation to the stone foundations during periods of severe cold weather.

We estimate that the costs of this regrading are modest, possible about $5,000.

3.4 General Exterior Repairs

The most important work is to replace the roof to eliminate water intrusions into the building. Then adding gutters and downspouts will collect the rain water and direct it away form the base of the building, further reducing the impact of the weather on the structure and the building walls and foundation. Then, other work is aimed at repairing the masonry and rehabilitating the windows, doors and shutters to arrest deterioration to these wooden elements. The windows and doors will also be more easily operated and improved hardware will assure building security. The specific work elements would be:

- Replace the roof with standing seam copper roofing. Install new hanging copper gutters and downspouts.
- Repoint eroded mortar joints and replace Portland cement mortar
- Undertake comprehensive rehabilitation of the window frames, sash, shutters, doors, and transoms
- Treat soil for termites and other insects

We estimate the costs for these general exterior repairs to be about $54,000. The use of a copper for the roofing and gutters can be assumed to provide a service life of 75 years or more. The current galvanized steel roof is about 30 years old and it is badly corroded. 25-30 years is generally assumed to be the service life of such roofs. The copper can easily be justified using life cycle cost analysis, however, if it proves important to reduce the estimated costs of this construction project, then galvanized steel roof panels can be substituted with a savings of about $12,000.

3.5 General Interior Repairs

Loudoun County has recently had the bird droppings removed and the attic sanitized. This is a very big benefit to this project since this other related work can now go forward with this encumbrance. The interior work related to structural stabilization and building preservation is limited to cleaning up the plaster debris, removing loose plaster that has been damaged by water, and the replastering the plaster walls. In addition, we recommend that the contractor prepare three neatly framed wooden hatches that provide access into the crawl space. We would set aside an arbitrary amount of money, say $1000 for minor repairs or proping of joists in the crawl space. We estimate that this interior work would be about $10,000.

No work is proposed at this time for the wooden balcony, the pews, or the flooring repairs or refinishing. No painting or other cosmetic work is anticipated within the stabilization work.

3.6 Summary Cost Estimate

The proposed work elements were broken into the following parts:

Structural Repairs and Reinforcements	$ 25,500
Site Drainage	5,000
General Exterior Repairs	54,000
General Interior Repairs	10,000
TOTAL	$94,500

This leaves just a few thousand dollars to cover unexpected changes during construction. This is estimate is conservative, but the actual value of the proposed work will not be known until the project is bid to contractors.

We will probably need to indicate that some work is optional to the contract. These optional work items are listed as bid alternates. This project is trimmed back to the very most important work efforts, so it is difficult to identify optional work elements. We will discuss this further with the MZCPA and Loudoun County to identify bid alternates as this design project proceeds.

3.7 Donated Funds and Services

There are several elements that may lend themselves to donation that will make a contribution toward preservation of the building and improve public utilization of the site. These are each clearly identifiable items which could be undertaken without regard to the implementation schedule for the stabilization work. Possible items would include:

- One recommended work item that is important, but not necessarily as urgent as the work noted above, is to re-install electricity to the structure. This will provide light and then smoke detectors and perhaps intrusion alarm devices could be added.
- Exterior lighting could be added which would help feature the building and possible offer protection against vandalism.
- Interpretive exhibits and exterior sign plaques will add to the public appreciation of the site.
- Portable toilets could be placed in a permanent location. With routine maintenance, these can improve site utilization.
- Further cleaning of the interior, perhaps modest efforts at repainting and other cosmetic improvements.

3.8 Next Steps

Upon review and approval of this elements of this stabilization plan, the A/E team will begin preparation of the plans and specifications for the work. The process of contractor selection and bidding will be reviewed and a firm schedule for procurement will be established. Upon approval of this report, approximately 8 weeks is needed to prepare the plans and specifications. We assume about 3 to 4 months is needed to advertise, bid and award the contract.